Predicting the Distribution and Properties of Buried Submarine Topography on Continental Shelves

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Award Number: N00014-00-1-0846

LONG-TERM GOALS

Compile geological data and develop methods to predict the distribution and properties of features hypothesized to be responsible for sonar geoclutter. Contribute to the reduction or mitigation of geologic clutter observed on fleet sonar systems.

Two issues define the problem.

• *Landscape forming issue*: In area 'x', can the Navy expect geoclutter features and if so what are their sonar characteristics, i.e. channel orientation?

• *Landscape burial issue*: If geoclutter features are expected in area 'x', will the features be exposed or buried? Areas of low interest to the Navy include locations where Holocene deposits are thick. Areas of high interest to the Navy include locations where Holocene deposits are thin thereby allowing for the shallow burial of Pleistocene topography.

JUSTIFICATION

A major goal of the U.S. Office of Naval Research is to reduce or mitigate geologic clutter observed on fleet sonar systems. Geological structures just beneath the seafloor, with high-angle reflecting surfaces, can return false sonar alarms. Examples include steep-walled channels from buried paleo-river valleys or iceberg furrows.

OBJECTIVES

• Define the character of different kinds of buried channels (size, shape, properties).

• Define the spatial distribution of these buried channels (river, tidal, hyperpycnal).

• Develop a global atlas of candidate geoclutter features and their characteristics.

• Develop and merge global databases of pertinent geological and oceanographic data.

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **30 SEP 2002**	2. REPORT TYPE	3. DATES COVERED **00-00-2002 to 00-00-2002**

4. TITLE AND SUBTITLE **Predicting the Distribution and Properties of Buried Submarine Topography on Continental Shelves**	5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Scripps Institution of Oceanography,University of California, San Diego,,La Jolla,,CA, 92093**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT
Compile geological data and develop methods to predict the distribution and properties of features hypothesized to be responsible for sonar geoclutter. Contribute to the reduction or mitigation of geologic clutter observed on fleet sonar systems.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**6**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

• Develop predictive models and apply to margins of interest. Test predictive models in a known geoclutter rich area.

• Share and merge these databases, models and results with those in the Geoclutter Research Group working on tracking algorithms.

APPROACH

1) Compile a global database of pertinent geological and oceanographic data, for use as initial inputs and constraints for sediment flux models (*HydroTrend* and *SedFlux*).

2) Measure and analyze terrain attributes. Perform a comprehensive analysis of real and simulated elevation grids using RiverTools® and other GIS software. Calculate the geometric and statistical characteristics of landforms and how these characteristics vary from one geologic setting to another.

3) Classify terrain from geologic information. Classify "terrain types" in terms of the initial and boundary conditions (e.g. geology, erosion rates, excess rain rates) that produced the terrain types, using physics-based landform models.

4) Determine the burial depth potential of low-sea level produced topography. Develop simple scaling relationships for deposition rate as a function of sediment input rates from rivers, wave and current conditions, and shelf geometry. Refine these bulk estimates with more detailed consideration of the nature of sediment delivery to the shelf (e.g., episodic storm-driven flooding vs. seasonal snowmelt flooding; the role of estuaries) and sediment redistribution, bypassing and deposition on the shelf (e.g., the long-term manifestation of short-term, episodic, storm-driven transport on the shelf).

5) Model the flux of sediment to and across continental shelves. Use process-based models (*HydroTrend*) to obtain a detailed consideration of the nature of sediment delivery to the shelf and sediment redistribution, bypassing and deposition on the shelf.

WORK COMPLETED

• Set up a GIS lab at SIO-UCSD. The lab consists of a SGI Octane2 with a RAID5 and 4mm tape drive for data storage, a dual-boot PC running Linux and Windows 2000, a Windows 2000 PC with 280 Gb of storage capacity and 4mm tape drive, 2 laptops (one dual-boot and one Windows 2000) for field activities, and a 400 Gb SNAP Server for additional storage. Software loaded on the SGI and the Linux machines includes GMT, Matlab, Sioseis, Seismic Unix, X-Sonar/Show Image and Fledermaus (a 3-D visualization software). The software installed on the PCs includes ArcView, ArcGIS, Arc/INFO, ER Mapper, PCI Geomatica, and standard software employed for data analysis and presentation. In addition, we recently installed at SIO a 10' x 30' PANORAM display screen used for 3-D data visualization (e.g., fly-throughs) that will improve outreach and discussion of data with large groups (~40 people).

• Examined literature for research conducted on the NJ margin. A great deal of oceanographic research has been conducted on the NJ margin, however, not all of it is relevant and/or useful to the goals of Geoclutter. Understandably, it is a time-extensive task to review the literature and identify and acquire data relevant to defining subsurface channels. Several studies are particularly relevant to

this research, however, much of the historical data are only available on microfilm and the quality of the data is poor. While initial literature search efforts were focused on the NJ margin, more effort is now focusing on the Mid-Atlantic Bight region to contrast with NJ observations.

• Searched major databases for surficial-seabed and seismic-trackline data on the NJ and SC margin and compiled these and other available data as shapefiles in ArcView projects (GIS) (Fig. 1). As described above, the main objective of the SIO research group is to provide field data to constrain the modeling efforts and provide input to the model runs. To that end, modern and historical data must be acquired and analyzed to provide information relevant to the model output. Regarding modern data, we are currently analyzing relevant seismic lines obtained from NJ and SC. The impact of glacial discharge and tidal processes need to be considered when examining the shelf channels. We have used the major institutional databases (e.g., NGDC and USGS) to incorporate surficial-seabed and seismic-trackline data. These datasets are being continuously compiled and updated with ArcView.

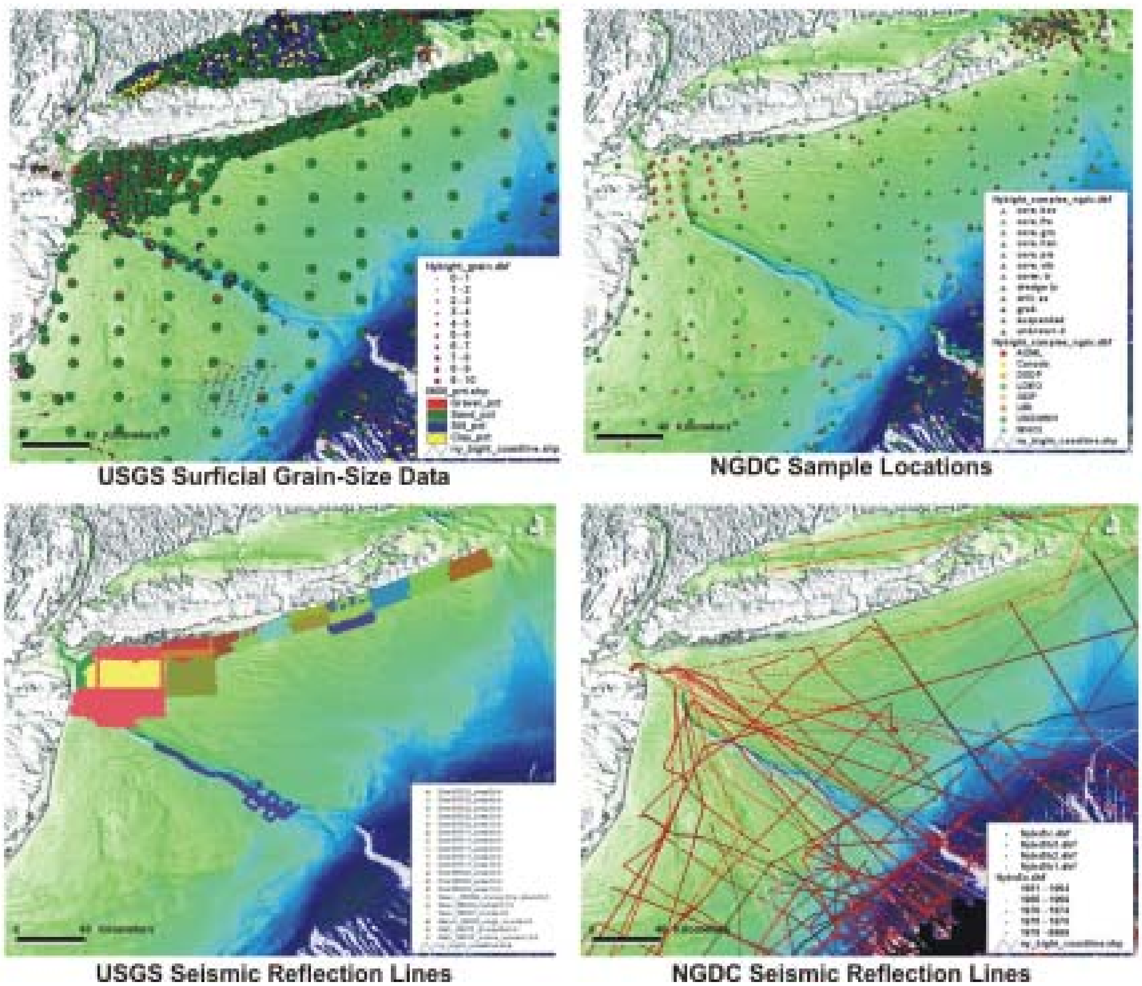

Figure 1: Examples of data incorporated into the NY Bight Geoclutter GIS Database.

• A protocol was established for making channel-attribute measurements of channel width, depth, sidewall-slope angles, overlying sediment and classification of channel shape and channel fill. Using

this system, measurements are made of available seismic data as well as published figures with channels (Fig. 2). These data are then entered into a shapefile, enabling channels to be queried and plotted according to their attributes. In addition, channels can be viewed in relation with other available sedimentological, bathymetric, or relevant data.

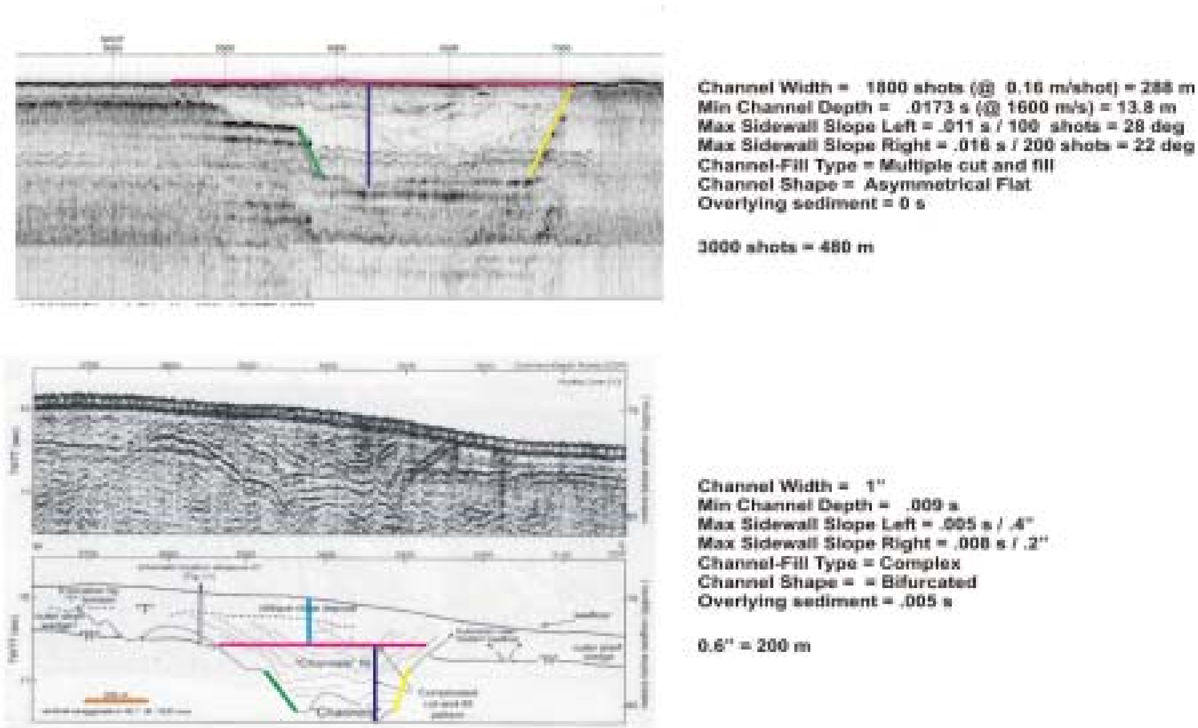

Figure 2: Examples of channel measurements being made on available (top) seismic data and (bottom) published figures (scanned from Duncan et al., 2000).

RESULTS AND INSIGHTS

Our research thus far has revealed some important insights. For example, several studies have identified the location of major ancestral river channels that traverse the U.S. East Coast continental shelf. These channels/valleys are typically hundreds of meters to kilometers wide with sidewall relief of tens of meters. Interestingly, many smaller channels also are evident along the coast, and these may be tidal in origin. Also important, the only notable surficial channels that traverse the U.S. East Coast continental shelf are the Hudson and Block Island Shelf Valleys, suggesting this region may have experienced larger discharge during the late Pleistocene. In summary, our research suggests that many fluvial channels on the mid to inner shelf have been overprinted by glacial and tidal processes.

PUBLICATIONS

Publications from Phase I of the Geoclutter project

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